# OPEN POSSIBILITIES.

# Next Generation Optics in Meta Data Centers - 200G and 400G pluggable optics







# Next Generation Optics in Meta Data Centers - 200G and 400G pluggable optics

Qing Wang, Optical Engineer, Meta Abhijit Chakravarty, Tech. Lead Manager, Meta Thang Pham, Optical Engineer, Meta Vincent Zeng, Manufacturing Quality Engineer, Meta Ruby Chen, Tech. Sourcing Manager, Meta









# Agenda

- Meta pluggable optics evolution
- 200G optics
  - Specs and performance in the early deployment
  - Manufacturing at scale
- 400G optics
  - Specs optimization
  - Quality and Manufacturing challenges
- Meta Sourcing strategies for pluggable optics
- Conclusion

## OPEN POSSIBILITIES.





# Meta pluggable optics evolution

2017	2021		
0	O		
12.8T Switch	25.6T Switch		
Radix * Optics Speed: 128 * 100GbE	Radix * Optics Speed: 128 * 200GbE/ 64 * 400		
NRZ	PAM-4		

200G QSFP56 FR4 (4 x 50G Host/ 4 CWDM WLs)

100G QSFP28 CWDM4

(4 x 25G Host/ 4 CWDM WLs)

400G QSFP56DD FR4

(8 x 50G Host/ 4 CWDM WLs)

## OPEN POSSIBILITIES.



Next Gen

51.2T Switch

OGE Radix \* Optics Speed: 128 \* 400GbE/ 64 \* 800GbE PAM-4



# **200G FR4 Optics**

## OPEN POSSIBILITIES.





**COMMUNITY**®



# Meta 200G FR4 key specs

ltem	Min	Мах		
Form factor	QSF			
Management interface	CMI			
Operation mode	100G,			
Power consumption (W)	_	6.5		
Case temperature (°C)	15	65		
Wavelength N (nm), N=0,1,2,3	1271+N*20-5.75	1271+N*20+5.75	WL range r (Meta)	
Tx OMA (dBm)	-2.2	4.5	Minimum T	
Rx OMA (dBm)	-7	-7 4.5		
Operating range	2m to	IEEE FR4 sp		

• Specs optimized based on Meta use case to improve the yield, support high volume, and promote integrated optics technology





### NETWORKING

### Note

educed from +/-6.5nm (IEEE) to +/-5.75nm

x OMA reduced by 1dB compared with IEEE

Rx OMA reduced by 1dB compared with IEEE

pecs is 2m to 2km



# Meta 200G FR4 Optics qualification

- Host systems
  - Minipack 2, Wedge400 etc
- Process
  - Spec Definition
  - Component level qualification (O/E performance, power/thermal/mechanical, interoperability, FW, EEPROM)
  - System level qualification (Interoperability, EMC, FW, power/ thermal/mechanical, communication interface, module management)

## )PEN POSSIBILITIES.





## Key performance metrics in the early deployment



PEN POSSIBILITIES.



**NETWORKING** 

### Early deployment data indicated good margin in the module performance



## Meta 200G FR4 MP challenge and strategy

### **Pre-Production: Optics Manufacturing Readiness Audit – Virtual**

The global COVID-19 crisis has impacted normal business operations (in-person mfg. audits)

- Meta's innovative virtual video audit process • Multiple cameras are used to view the entire production floor
- Audit can be held over multiple days to allow for adequate time and focus on particular topics
- LIVE virtual video audits enable more attendees from Meta for a more comprehensive meeting
- Virtual Audits still align with our structured audit procedure
- Eliminate COVID 19 travel restrictions
- Multiple sites can be audited within a short period of time
- Production stations can be viewed closely

## )PEN POSSIBILITIES.





**NETWORKING** 



## Meta 200G FR4 MP challenge and strategy

### **Post-Production: Global material shortage & ~4X PCN(s) qualification**

- **High demand** for 200G FR4 in 2021, 2022 & beyond
  - Material inventory, capacity Ramp strategy, PCN Qual (Dual Source)

### Mfg. Ramp Enablement

- Mfg. and test capacity ramp analysis
- yield improvement, production line throughput and utilization assessment
- Monthly capacity ramp audits for multiple mfg. sites

### Risk Mitigation

- Quality control process/Milestone review
- Customized ORT & long-term reliability processes
- Dual Sourcing
  - Critical components via ECN/PCN
- **New supplier** qualification to de-risk supply

## )PEN POSSIBILITIES.







## Meta 200G FR4 MP challenge and strategy

### **Post-Production: Meta's long-term reliability for pluggable optics**



### • Test setup & conditions

- Multiple OCP switches (Wedge for 100G, Minipack for 200G)
- Thermal chamber for continuous TC test
- 0 degree C to 65 degree C optics case temp (4-5 cycles/day)
- Critical parameter monitoring (24X7) such as Tx power, Rx power, Bias, Temp etc.

## OPEN POSSIBILITIES.



### gy optics



### NETWORKING



# 400G FR4 Optics

## OPEN POSSIBILITIES.





**COMMUNITY**®



# Meta 400G FR4 Specs optimization

- Requirements:
  - Support Meta's new switches such as W400, Minipack2, Arista 7388  $\bigcirc$
  - Fully backward compatible with 200G QSFP56  $\bigcirc$
  - Optically forward compatible with 800G optics  $\bigcirc$
- Specs development:
  - IEEE 802.3cu is the baseline
  - Temperature range is reduced to 15-70°C  $\bigcirc$
  - Customized lane mapping to fully support backward compatibility  $\bigcirc$
  - Full specs also include Management, EMC, Quality and Reliability...  $\bigcirc$
  - Specs is submitted to OCP for review and approval

## PEN POSSIBILITIES.





# 400G FR4 key specs

Specification	Min	Мах	
Form factor	QSFP-DD		
Management interface	CMIS4.0		
Operation mode	400G/200G		
Dower concurrention (141)		10.5	
Power consumption (w)		7.0	
Temperature(°C)	15	70	
Operating range	2m to 3km		
Link loss (dB)		4.0	
	1265.25	1276.7	
Wavelength range (nm)	1285.25	1296.7	
	1305.25	1316.7	
	1325.25	1336.7	
Lane mapping	(Host side) (1,5), (2,6), (3, 7), (4, 8)	⇒1, 2, 3, 4 (Line s	
OPEN POS	SIBILITIES.		

	Note NETWORKING
	400G mode
	200G mode
	IEEE FR4 specs is 2m to 2km
	Same as IEEE FR4
<sup>′</sup> 5	
5	WL range reduced from 13nm to
5	11.5nm
5	
side)	200G mode uses host lanes 1-4
	similar to 200G QSEP56 GLOBAL
	NOVEMBER 9-10, 2021

# **Optics Reliability and Quality Assurance**

**Reliability and Quality Performance Target for the module established** 

Lifetime and Target FIT/MTBF/AFR						
Device Level	Definition	Life Time (year)	FIT (1st year, 95% CL)	FIT (95% CL)	MTBF (hrs)	AFR
Current Integrated Optical Device	Optical Module (Pluggable)- inlcuding-Silicon Photonic Optical Engine (OBO/CPO)-With Laser	6	1000	300	3.3M	0.26%

- Reliability comes from build rather than test-ensure the smooth production steep ramp
  - Mode hopping control from laser die, COC and module level
  - Laser Burn-In optimization to drive down the FIT (mainly infant mortality) Ο
  - Consistent process for building block for different SKUs
- Operational Control Quality
  - ORT (Ongoing Reliability Test) in place  $\bigcirc$
  - MAP (Manufacturing Analytics Portal) in place  $\bigcirc$

## EN POSSIBILITIES.



### **NETWORKING**



# Meta Optics Sourcing Strategy



PEN POSSIBILITIES.



Compatibility with existing network topology -> scale up switch bandwidth while preserving radix and fiber cabling (e.g. standard duplex LC requirement)



# Call for Action

Meta has started deployment of 200G and 400G optics on 25.6Tbps switch fabric in our data centers. Specification is optimized in both optics to address the scale for Meta deployment.

- DFx for Security of Supply from component level to module level
- **Technology with higher degree photonic integration**
- **Time to Market**
- **Power/Thermal/Mechanical/EMC**
- **Enhanced Telemetry/Diagnostic Capability**
- Reliability
- **Standard Alignment**

## OPEN POSSIBILITIES.





# Meta contributors (Alphabetical)

Absar Ulhassan	Dennis David	Rob Stones	Song Yu
Anju John	Freddy Mercado	Lingjun Wu	Tian Fang
Aron Bishop	Hany Morsy	Kevin Hicks	Tom McCandlish
Chenfei Lin	Harshit Gulati	Max Devyatov	Victor Blake
Chet Powers	Herman Chin	Melody Liu	Vignesh Vijayanath
Chintu Abraham	Ivy Wu	Nadim Sarras	Vimal Vasudevan
Chris Berry	James Stewart	Naomi Kalyani	Xuan He
Chris Olesiewicz	Jeff Price	Nhan Hoang	Xu Wang
Chunliang Zheng	Jimmy Leung	Rajan Kumar	Yevgeniy Rombakh
Danielle Murphy	Jiu Xu	Sami Khan	Yishen Huang





### NETWORKING

NOVEMBER 9-10, 2021

# **Open Discussion**



NOVEMBER 9-10, 2021

# 400G-FR4 Electrical/optical lane mapping

- To support 200G backward compatibility requirement, the mapping of electrical input/output lanes from QSFP-DD connector to optical wavelengths of the 400G-FR4 module is customized
- In 200G mode, 4 active host lanes are 1-4, similar to 200G QSFP56





POSSIBILITIES.



### 200G mode and 200G QSFP56